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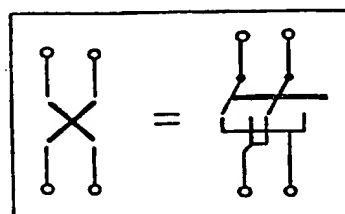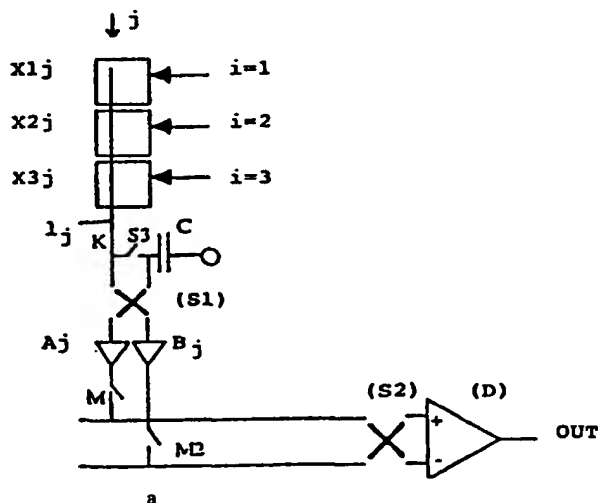
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(54) Title: DEVICES AND METHODS FOR IMPROVING THE IMAGE QUALITY IN AN IMAGE SENSOR

(57) Abstract

The present invention is related to an image sensor comprising an array of rows (i) and columns (j) of pixels (X_{ij}), all the pixels of one column of the array being connected to at least one common pixel output line (l_j) having at least one memory element (M_j) and at least a first amplifying element (A_j), all these amplifying elements (A_j) being connected to a common output amplifier (D). According to one preferred embodiment, said image sensor comprises: a second amplifying element (B_j) on the output of the memory element (M_j); said common output amplifier (D) having at least two input terminals; means (S1) for switching the pixel's signal on the common output line (l_j) and the memory element's signal (M_j) to respectively third and second amplifying element (A_j and B_j) of one column; and means (S2) for switching the two output signals of the amplifying elements (A_j, B_j) of one column to respectively first and second input terminals of said common output amplifier (D).

a

b

5

DEVICES AND METHODS FOR IMPROVING THE IMAGE QUALITY IN AN IMAGE SENSOR

10

Field of the invention

The present invention relates to solid state imaging devices being manufactured in a CMOS- or MOS-technology.

15   More particularly, the principal object of the present invention is related to methods and devices which are able to improve the image quality in an image sensor.

Another object of the present invention is
20 related to the improvement of the image quality by a method of correcting isolated pixel values present in an image taken by imaging devices.

Background of the invention

25   Solid state image sensors are well known. Virtually all solid-state imaging sensors have as key element a photosensitive element being a photoreceptor, a photo diode, a photo transistor, a CCD gate, or alike. Typically, the signal of such a photosensitive element is a
30 current which is proportional to the amount of electromagnetic radiation (light) falling onto the photosensitive element.

A structure with a photosensitive element included in a circuit having accompanying electronics is

called a pixel. Such pixel can be arranged in an array of pixels so as to build focal plane arrays of rows and columns.

5   Commonly such solid state image sensors are implemented in a CCD-technology or in a CMOS- or MOS-technology. Solid state image sensors find a widespread use in devices such as camera systems. In this application a matrix of pixels comprising light sensitive elements constitutes an image sensor, which is mounted in the camera
10   system. The signal of said matrix is measured and multiplexed to a so-called video-signal.

        Of the image sensors implemented in a CMOS- or MOS-technology, CMOS or MOS image sensors with passive pixels and CMOS or MOS image sensors with active pixels are
15   distinguished. An active pixel is configured with means integrated in the pixel to amplify the charge that is collected on the light sensitive element. Passive pixels do not have said means and require a charge sensitive amplifier that is not integrated in the pixel. For this
20   reason, active pixel image sensors are potentially less sensitive to noise fluctuations than passive pixels. Due to the additional electronics in the active pixel, an active pixel image sensor may be equipped to execute more sophisticated functions, which can be advantageous for the
25   performance of the camera system. Said functions can include filtering, operation at higher speed or operation in more extreme illuminations conditions.

        Examples of such imaging sensors are disclosed in EP-A-0739039, in EP-A-0632930 and in
30   US-A-5608204. The imaging devices based on the pixel structures as disclosed in these patent applications however are still subject to deficiencies in the image quality of the devices.

A problem in these CMOS based imaging devices appears because material imperfections and technology variations have as effect that there is a non-uniformity in the response of the pixels in the array. This effect is

5 caused by a non-uniformity or fixed pattern noise (FPN) or by a photoresponse non-uniformity (PRNU). Correction of the non-uniformity needs some type of calibration, e.g. by multiplying or adding/subtracting the pixel's signals with a correction amount that is pixel-dependent.

10 Several methods to cancel FPN are based on techniques that are often called correlated double sampling or offset compensation. The methods in general are based on the following: the signal of the pixel is subtracted from the signal of the same pixels in a reference state (this

15 reference state is typically the reset or dark state). The difference of both signal is free of pixel-related non-uniformity. However, if the differencing circuit is common for a part of the imager (typically, common for one column), a new non-uniformity will originate due to the

20 non-uniformity of the differencing circuits. In a typical APS imager with common column buffers or column amplifiers, the new fixed pattern noise is column dependent, and is visible in the image as a shade of vertical stripes.

A stripe-shaped FPN is much more annoying

25 than a pure statistical FPN. It is seen in experiments that a true random FPN of 5% RMS is barely visible to the human eye, whereas a stripe-shaped FPN remains visible even when the amplitude is below 1% RMS. The reason is that the human eye has a kind of built-in spatial filter that recognises

30 larger structures even when they have low contrast.

Even if in the case that we have no fixed pattern noise, the photoresponse non-uniformity can be different from 0.

Another problem arises due to processing imperfections, statistics, etc. This means that typically, a finite number of pixels in a pixel array will be defective (hard faults) or yield a signal that deviates
5 visibly from the "exact" pixel value. Such faults appear as white or black (or grey) points in the image. This class of faults in the sequel is called an isolated pixel value.

A known way to cancel these spots is to store a list of them and of their positions in the image in a
10 memory unit in the device. In an image processing step, the isolated pixel value is then replaced by e.g. the average of the surrounding pixels. This method is viable, but has the disadvantage that it requires a memory. Moreover, it cannot handle isolated pixel values that appear
15 intermittently or only in certain cases. A good example, is a so-called dark current pixel. Such pixels will appear white in a dark environment, but will behave normal in a bright environment.

Other ways to cancel isolated pixels faults
20 have been proposed, e.g. the spatial median filter or other types of Kalman filters can be used to remove such isolated faults. Unfortunately, such filters do also remove useful detail from the image. Consider the image of a star covered sky with an image sensor that has some faulty pixels that.
25 appear white. The quoted filters are not able to remove the white point due to faults, and leave the white points that are stars untouched.

Aim of the invention

30 The present invention aims to suggest a pixel structure and methods to improve the image quality, more in particular the image non-uniformity of in array of pixels by. cancellation of the appearance of column-shaped fixed pattern noise (FPN).

Main characteristics of the present invention

As a first object, the present invention is related to an image sensor comprising an array of rows and columns of pixels, all the pixels of one column of the
5   array being connected to at least one common pixel output line having at least one memory element and at least a first amplifying element, all these amplifying elements being connected to a common output amplifier.

According to one preferred embodiment, the
10   image sensor further comprises :

- a second amplifying element on the output of the memory element,

- said common output amplifier having at least a first and a second input terminals,

15   - means for switching the pixel's signal on the common output line and the memory element's signal to respectively first and second amplifying elements of one column, and

- means for switching the two output signals of the
20   amplifying elements of one column to respectively first and second input terminals of said common output amplifier.

Preferably, the switching means comprise at least one cross-bar switch.

25   According to another preferred embodiment, the image sensor further comprises before the amplifying element two parallel circuits being connected through switches to the common pixel output line, at least one circuit having said memory element. Preferably, both
30   circuit have a memory element.

According to another preferred embodiment, said common pixel output line is being connected through switches to said memory element and said amplifying

element, where the offset of the amplifying element is
stored on the memory element during a first phase of the
read-out, and this offset is subtracted from the signal of
the amplifying element during the second phase of the read-
5 out.

The present invention is also related to a
method of reading out an array of rows and columns of
pixels in an image sensor as described hereabove according
to the first embodiment, comprising the steps of:

10 — amplifying the output signals of essentially each pixel
       of one column in the first amplifying element thereby
       obtaining a set of amplified pixel output signals,

    — amplifying the reference signals of essentially each
       pixel of one column in the second amplifying element,
15   thereby obtaining a set of amplified pixel reference
       signals,

    — consecutively, for essentially each pixel of said column
       imposing the amplified pixel output signal to a first or
       a second terminal of said common output amplifier and
20   imposing the amplified pixel reference signal to a
       second or a first terminal of said common output
       amplifier, while switching the amplified pixel output
       signal to respectively said first and said second
       terminals for essentially each consecutive pixel of said
25   column, said reference signal being imposed to the other
       terminal of said common output amplifier.

A voltage can be imposed to a node. In this
case, it means e.g. that the node is connected to a voltage
source. The voltage source should be higher than the node,
30 i.e. it should have a lower impedance.

According to another preferred embodiment,
the present invention is related to a method of reading out
an array of rows and columns of pixels in an image sensor

as described hereabove in the second embodiment of the present invention, comprising the steps of :

- sampling the signal in a first phase and storing it in a memory element,

5   - sampling the signal in a second phase and possibly storing it in another memory element,

- subtracting said first signal from said second signal in a unique output circuit.

According to another preferred embodiment,
10   the present invention is related to a method of reading out an array of rows and columns of pixels in an image sensor as described in the third embodiment of the present invention, comprising the steps of :

- during a first phase, calibrating the output of the
15   amplifying element to a predetermined value,

- storing said value in a memory element during the application of a first signal of said pixel on the line,

- during a second phase, applying a second signal of said pixel on the line in order to have on the output a signal
20   proportional to the difference between first and second signals.

Another aspect of the present invention is related to a method of replacing an isolated pixel value in the image of an image sensor, being an array of pixels, and
25   wherein at least one current source is connected to the pixels, the method comprising the step of :

- limiting said isolated pixel value between or to an upper and/or a lower bound that is derived from the values of pixels in the immediate neighbourhood of the
30   said isolated pixel value.

Preferably, said upper and/or lower bounds are found by extrapolating the immediate neighbourhood pixel values towards a value that corresponds to the

position of said individual pixel in relation to the immediate neighbourhood pixels.

Said upper and/or lower bounds are found by extrapolating the values of a neighbour (V_1N) of the pixel

5   having said isolated pixel value and of the neighbour thereafter (V_2N), the replacing pixel value being calculated as $V_1N+n*(V_1N-V_2N)$, n being a real number.

The neighbourhood and the neighbourhood thereafter are on the same row of said array. Preferably,

10   the upper bound is the maximum of a set of values, said set being determined as the pixel values (a,b,c,d,e) of pixels on the same row of said array as said isolated pixel, said upper bound being calculated as

cmax = $F(a,b,c,d)$, or cmax $G(E(a,b), E(e,d), E(b), E(d))$

15   where F is a non-linear or linear function, G is a non-linear GE or linear function, E is an extrapolating function, wherein cmax= $MAX(2b-a,2d-e,b,d)$
together with

cmin= $MIN(2b-a,2d-e,b,d)$

20   with MAX () yielding the maximum, respectively the minimum of the arguments, the corrected c-value being obtained as

c=$MIN(MAX(c,cmin),cmax)$.

25   **Brief description of the drawings**

Figure 1a   represents a particular implementation of a column FPN cancellation method and the corresponding image sensor structure therefor.

30   Figure 1b   represents an embodiment of a cross-bar switch used in the structure represented in Fig. 1a.

Figure 2   describes another particular implementation
                    of a column FPN cancellation method and the
                    corresponding   image   sensor   structure
                    therefor.

5   Figure 3   describes a particular embodiment of an
                    output block being used in the structure as
                    represented in Fig. 2.

Figure 4   represents the switching diagram for the
                    read-out signal applied to the several
10   switches in the structure as represented in
                    Fig. 2.

Figures 5   represent another particular implementation
                    of a column FPN cancellation method and the
                    corresponding   image   sensor   structure
15   therefor, wherein Fig. 5a represents more
                    particularly one column in an array of pixels
                    being connected to two different structures
                    represented in details in Fig. 5b and 5c
                    during a first phase and a second phase.

20 Figure 6   represents the specific topology used for the
                    structure represented in Fig. 5b and 5c.

Figure 7   represents the switching diagram for the
                    read-out sequence to the several switches
                    used in the structure represented in Fig. 6.

25 Figures 8a and 8b represent a method of correcting
                    isolated white pixel values being present in
                    an image composed by an array of pixels.

Brief description of preferred embodiments of the present

30 **invention**

As a first object of the present invention, a
first structure of an APS image sensor is represented in
Fig. 1. References (X_{1j}), (X_{2j}) and (X_{3j}) are three pixels

of a column of an image sensor. The pixel's signal on a common output line (l_j) is represented in particular by the column bus "K" in the present case and is fed to the optional buffer amplifier A_j, and/or stored on a memory

5 element (capacitor C + switch S3), and fed to amplifier B_j. By the relative timing of the addressed pixel's reset pulse and the control of the switch S3, one can make that the pixel's signal and its reference level are available on amplifiers A_j, reps. B_j. The fact that the signal passes

10 through the column amplifiers A_j and B_j, is a source of offset non-uniformity, which is column related and causes a vertical stripe-shaped FPN. More specifically, each column will feature an average "OV" offset voltage referred to the average of the other columns.

15   Switches (S1) and (S2) are crossbar switches. Suppose that they are in the forward direction either in crossed directions. Both switches S1 and S2 operate synchronously. In both cases, the signal on the capacitor C goes to the input of the output amplifier, and the signal

20 on K goes to the + input of the output amplifier. Yet, the "OV" of the column will be positive in the one case and negative in the other case. Since the switches (S1)/(S2) are modulated, e.g. essentially turned direction at each new row (i = 1, 2, 3) of the image, the average offset of a

25 column will be zero. For each individual pixel of a column, there will be indeed remain an offset which is + or - OV but this is a very small feature, and is not recognised by the eye as a stripe.

          Another embodiment of the present invention

30 is to suggest a read-out scheme for image sensors that suppresses the effects of non-uniformities caused by variations in pixels as well as variations in the output amplifiers. This read-out scheme can be used in sensors

that provide the output signal in terms of a difference. For example, in a sensor with integrating pixels, this difference is the voltage between the output when the pixel is on reset state and the output voltage after integration
5   time.

Namely the method suggests to subtract the signal when a pixel is reset from the signal after the integration time, in order to have a signal which is free from pixel variations. In order to avoid the introduction
10 of the non-uniform column amplifiers effects, the signal of the reset state as well as the signal after integration are sampled and held by the column read-out circuit. Finally, the subtraction is being carried out by a unique subcircuit at the sensor's output (D). This is detailed in Fig. 2.

15   For every row of pixels the read-out process is, of course, identical. Let us assume that the ith row is selected. When pixels are reset, the switches controlled by the signal $\Phi1$, are closed, thus the reset-level output of every pixel on the ith row, namely x'_{ij}, is stored on the
20 corresponding memory element M_{rj} (which is in the present case a capacitor).

Then, the switches $S4_j$ controlled by $\Phi1$ are opened and pixels start integrating the charge carriers produced by the impinging light. After the lapse of the
25 integration time, the switches $S5_j$ controlled by $\Phi2$ are closed, thus storing the values of the pixel output to the memory element M_{sj} (also a capacitor). This value, for the pixel with coordinates ij is denoted as x'_{ij}.

After the sample and hold phase for the two
30 voltages, x'_{ij} and x'_{ij}, for the first column and by proceeding from the first column to the last, the

appropriate column read-out circuit is connected with the output.

When the ith column has been selected, the signal Φ3 drives the switch S6$_j$ to led the signal x_{ij}^r to the output modified according to the action of the column amplifier, so as a signal

$$y_{ij}^s = A_j\, x_{ij}^s + B_j \qquad\qquad (1)$$

is led to block D (common output amplifier).

The block D is an easily realisable circuit with an output

z(n) = [y(n) - y(n-1)]   (2)

where y(n) denotes the input as instant n.

A preferred embodiment of such output block (D) is described in details in Fig. 3. Therefore, the output signal will be free from variations in the characteristics of pixels and the column amplifiers.

$$y_{ij}^r - y_{ij}^s = A_j \left(x_{ij}^r - x_{ij}^s \right) \qquad\qquad (3)$$

where A$_j$ is easily reproducible, by example by using source followers as the local final phase of the column circuits (when A$_j$ = 2, B$_j$ = -V$_{thj}$).

Fig. 4 shows a switching diagram for the above-mentioned read-out circuit wherein Φ3 is controlling S4$_j$, Φ4 is controlling the switch S5$_j$ and Φ5 is controlling the switch S6$_j$.

According to another embodiment of the present invention, an attempt to overcome the problem of offset introduced by the column in a image sensor consisting of pixels is described in Figs. 5 & 6, which can be used with pixels that are read-out twice in every access. For example, in integrating pixels, one read

operation is being performed when the pixel is set on the reset phase (first phase) and the second read-out moment is after a certain integration time (second phase), the first phase is defined by a period wherein the read-out signal of

5 the pixel is according a first state while the second phase is defined by a period such as an integration period where the read-out signal of the pixel is in another state.

In the first phase, when pixel output is V_1, the capacitor C stores a charge :

10 $$Q = C(V_{ac}-V_{out}) = C(V_{ac}-V_1+V_{th}) \qquad (4)$$

where V_{th} is the threshold voltage of μ.

During second phase, when pixel output is V_2, the capacitor stores again charge Q which now can be expressed as :

15 $$Q = C(V_{g\mu}-V_2) \qquad (5)$$

where $V_{g\mu}$ is the gate voltage of μ.

From (4) and (5), we obtain :

$$V_{g\mu} = V_2-V_1+V_{ac}+V_{th} \qquad (6)$$

Therefore :

20 $$V_{out} = V_2-V_1+V_{ac} \qquad (7)$$

i.e. the output voltage does not depend on the V_{th} (where variations in the V_{th} cause offsets in the signal V_{out}).

The column amplifier can be implemented by using the topology described in details in Fig. 6.

25 Switches S7, S8, S9, S10 and S11 are being controlled by signals $\Phi5$ and $\Phi6$ (when Φi is high, the corresponding switches are closed) as represented in Fig. 7.

According to a preferred embodiment

30 represented in Fig. 7, S7, S8 and S9 are controlled by $\Phi5$ while S10 and S11 are controlled by $\Phi6$ (when Φi is high, the corresponding switches are closed). This means that $\Phi5$

is describing the situation represented in Fig. 5b while Φ6 is representing the situation represented in Fig. 5c.

According to another aspect, the present invention is able to discriminate between isolated pixel

5 faults and features in the real image. In the case of an image of a star covered sky, it should be noted that the fact that the image projected through a lens is never perfèctly sharp. Even with good lenses, a star image is not projected on a single pixel. Always the point like source

10 of the start will be smeared out over a central pixel and a few neighbours. In a 1-dimensional cross section, a star image will look like the image in Fig. 8a, while an isolated pixel fault will look like in Fig. 8b.

In the above simple example, the peak in

15 Fig. 8b should be removed, while the peak in 8a should remain untouched.

The advantage is clear, only device faults are corrected while normal images are left untouched. The operation causes no visible image degradation in faultless

20 parts of the image.

According to this second aspect of the present invention, a method to remove an isolated whiter or darker pixel from the image is suggested. This method consists in limiting the value of every individual pixel

25 between an upper and/or a lower bound that is/are derived from the values of pixels in the intermediate neighbourhood of the said pixel.

Preferably, the upper and/or lower bounds are found by extrapolation of the neighbourhood pixel values

30 towards the position of the said individual pixel. The upper and/or lower bound are/is a combination of one or several such 1-D or 2-D extrapolations done with different

methods, and/or from different sides of the said individual pixel.

Preferably, extrapolation is the linear extrapolation of a neighbour (N1) of the said individual
5   pixel (IP) and the neighbour thereafter (N2). The extrapolated value is calculated as 2*N1-N2 or more general: N1 + n* (N1-N2) where the parameter n is a real number, typically between 0 and 3.

According to another preferred embodiment,
10 the calculation of the upper bounds is performed by extrapolating values from the two sides of said individual pixels. The advantage is that only the pixels data in 1 line of an image are required, which saves memory and operations and allows straightforward implementation as a
15 pipelined filter. Also such a filter is able to correct a vertical line defect.

In the example of Figs. 8a and 8b, five pixels in a neighbourhood (a 5-pixel "kernel") are taken. The experience is that smaller kernels do not yield good
20 results. Larger kernels may give some improvements compared to the 5-pixel kernel.

CLAIMS

1. An image sensor comprising an array of rows (i) and columns (j) of pixels (X_{ij}), all the pixels of one column of the array being connected to at least one common pixel output line (l_j) having at least one memory element (M_j) and at least a first amplifying element (A_j), all these amplifying elements (A_j) being connected to a common output amplifier (D), characterised in that the sensor further comprises:

– a second amplifying element (B_j) on the output of the memory element (M_j),

– said common output amplifier (D) having at least two input terminals,

– means (S1) for switching the pixel's signal on the common output line (l_j) and the memory element's signal (M_j) to respectively third and second amplifying elements (A_j and B_j) of one column, and

– means (S2) for switching the two output signals of the amplifying elements (A_j, B_j) of one column to respectively first and second input terminals of said common output amplifier (D).

2. An image sensor as recited in claim 1, wherein said switching means comprise at least one cross-bar switch.

3. An image sensor comprising an array of columns and rows of pixels (X_{ij}), all the pixels of one column of the array being connected to at least one common pixel output line (l_j) having at least one memory element (M_j) and at least one amplifying element (A_j), all these amplifying elements (A_j) being connected to a common output amplifier (D), characterised in that before the amplifying

element (A_j), the common pixel output line (l_j) is divided through switches ($S4_j$ and $S5_j$) in two parallel circuits, at least one circuit having said memory element (M_j).

5   4. An image sensor as recited in claim 3, wherein both circuits have a memory element (Ms_j and Mr_j).

5. An image sensor comprising an array of columns and rows of pixels (X_{ij}), all the pixels of one column of the array being connected to at least one common pixel output line (l_j) having at least one memory element 10 (M_j) and at least one amplifying element (A_j), all these amplifying elements (A_j) being connected to a common output amplifier (D), characterised in that said common pixel output line (l_j) is being connected through switches ($S7_j$, $S8_j$, $S9_j$ and $S10_j$, $S11_j$) to a memory element (C_j) and an 15 amplifying element (μ_j), where the offset of the amplifying element is stored on the memory element during a first phase of the read-out, and this offset is subtracted from the signal of the amplifying element during the second phase of the read-out.

20   6. A method of reading out an array of rows and columns of pixels (X_{ij}) of an image sensor according to claim 1, comprising the steps of :

- amplifying the output signals of essentially each pixel of one column in the first amplifying element (A_j) 25   thereby obtaining a set of amplified pixel output signals,

- amplifying the reference signals of essentially each pixel of one column in the second amplifying element (B_j), thereby obtaining a set of amplified pixel 30   reference signals,

- consecutively, for essentially each pixel (i = 1, 2, 3)

of said column imposing the amplified pixel output
signal to a first or a second terminal of said common
output amplifier (D) and imposing the amplified pixel
reference signal to a second or a first terminal of said
common output amplifier (D), while switching the
amplified pixel output signal to respectively said first
and said second terminals for essentially each
consecutive pixel of said column, said reference signal
being imposed to the other terminal of said common
output amplifier.

7. A method of reading out an array of rows
and columns of pixels (X_{ij}) of an image sensor as recited
in claim 3, comprising the steps of :

- sampling the signal in a first phase and storing it in a
memory element (M_{ij}),

- sampling the signal in a second phase and possibly
storing it in another memory element,

- subtracting said first signal from said second signal in
a unique output circuit (D).

8. Method as recited in claim 7, wherein said
first phase is the reset phase and said second phase is
after the integration period.

9. A method of reading out an array of rows
and columns of pixels (X_{ij}) of an image sensor as recited
in claim 5, comprising the steps of :

- during a first phase, calibrating the output of the
amplifying element to a predetermined value,

- storing said value in a memory element during the
application of a first signal of said pixel on the line,

- during a second phase, applying a second signal of said
pixel on the line in order to have on the output a signal
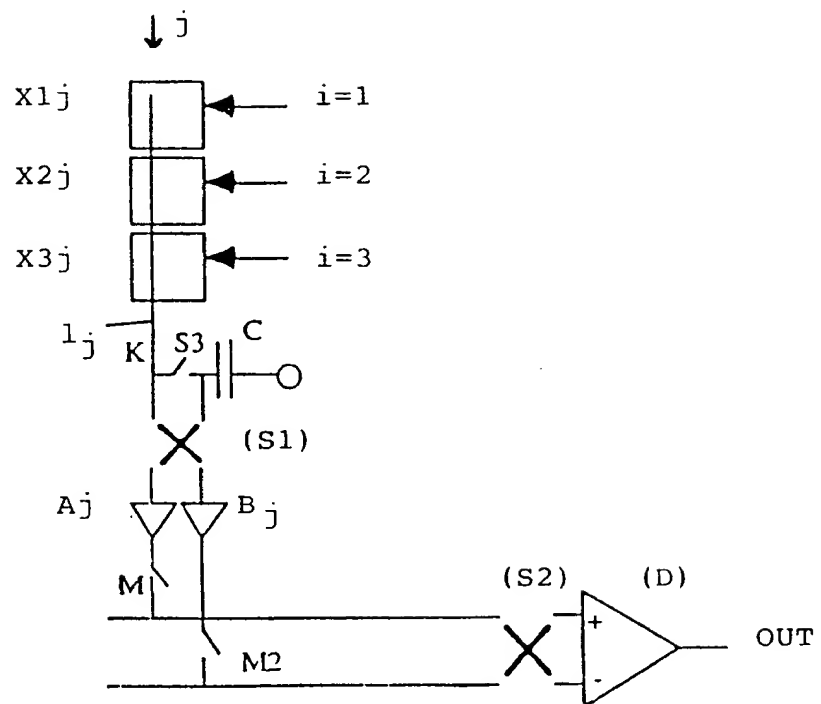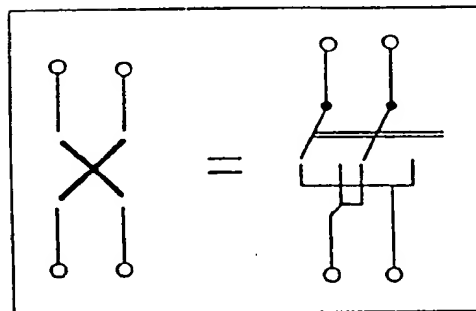proportional to the difference between first and second
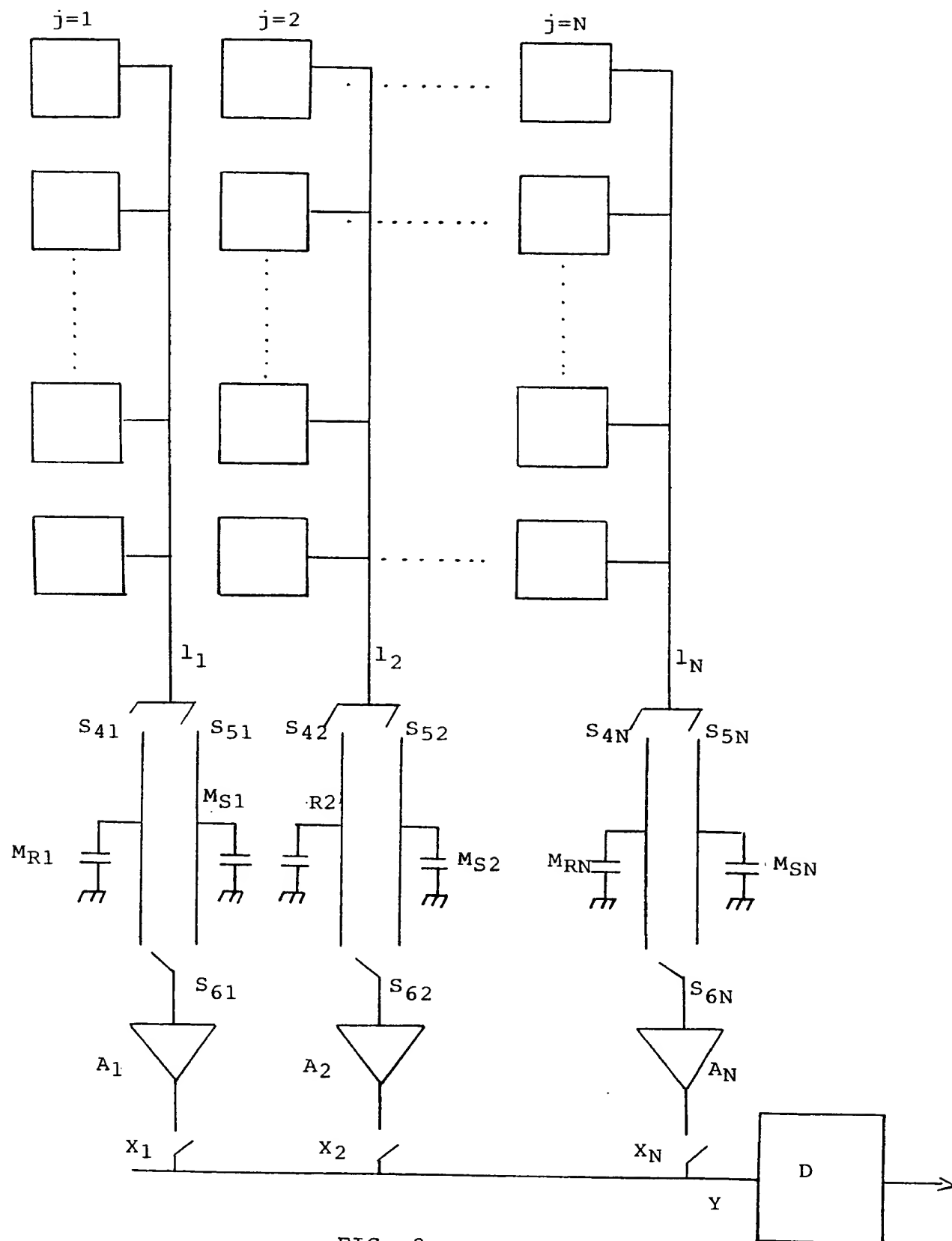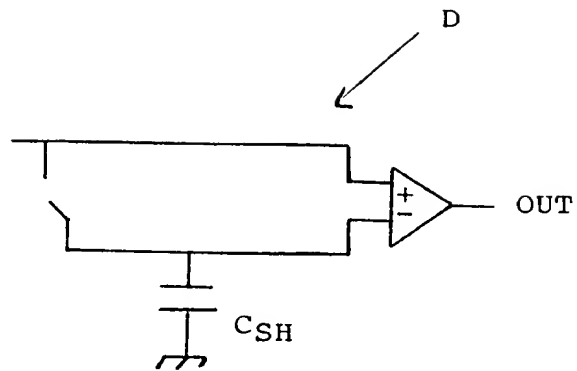signals.

FIG. 1a

FIG. 1b

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FIG. 2

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FIG. 3
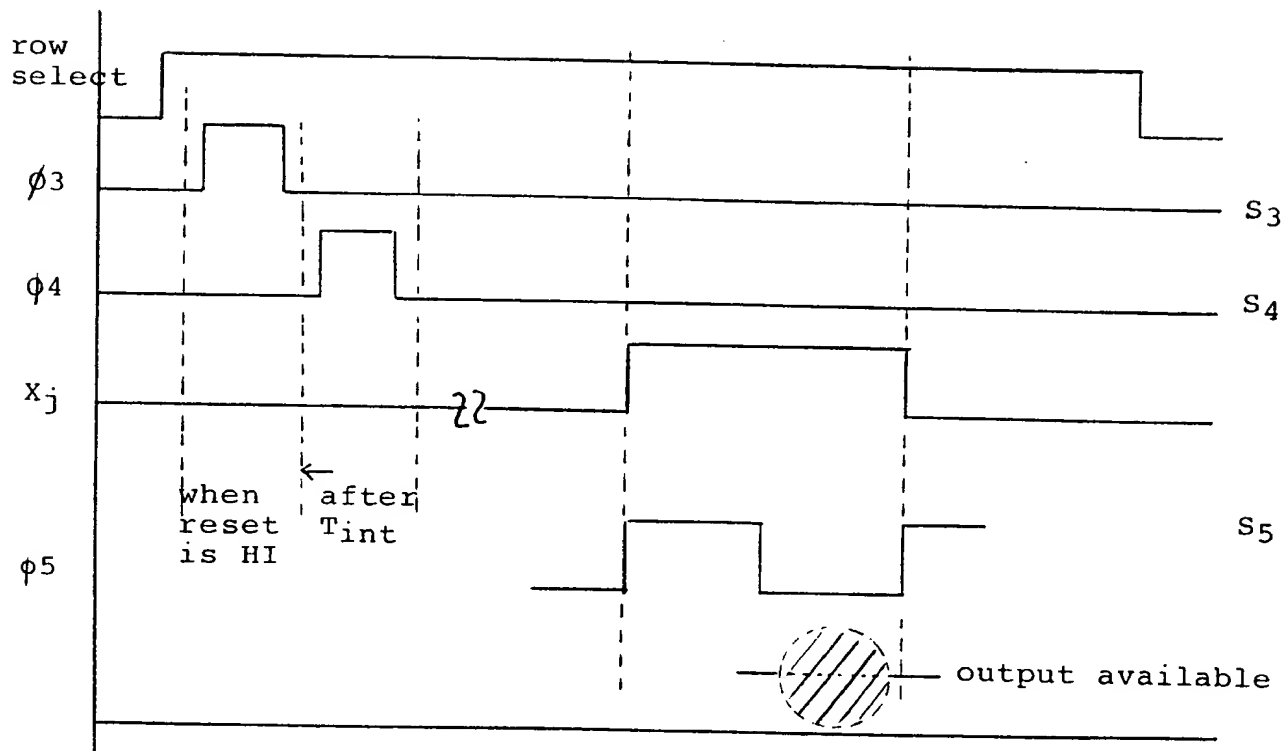
FIG. 4

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FIG. 5a

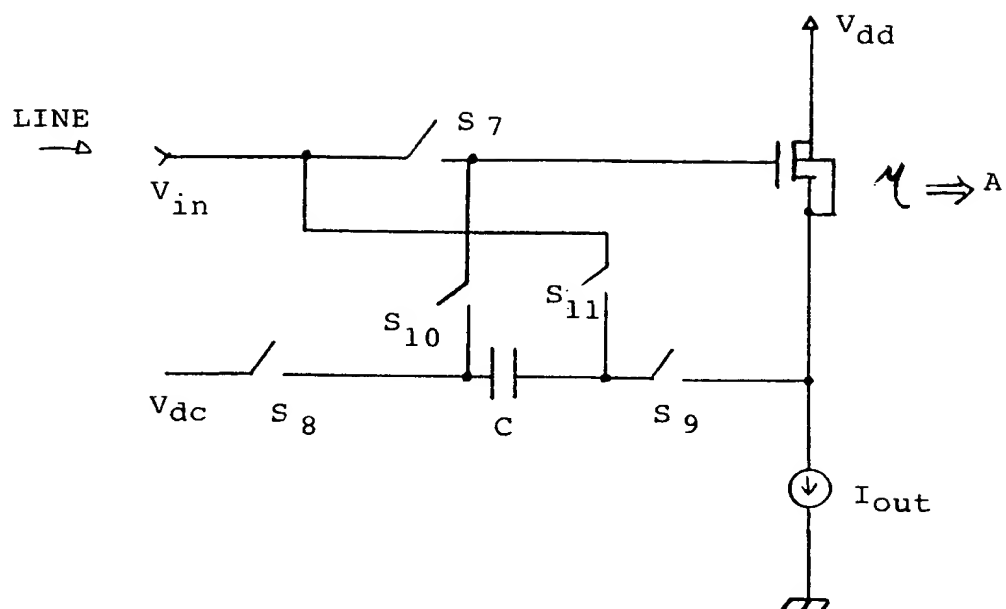FIG. 5b

FIG. 5c
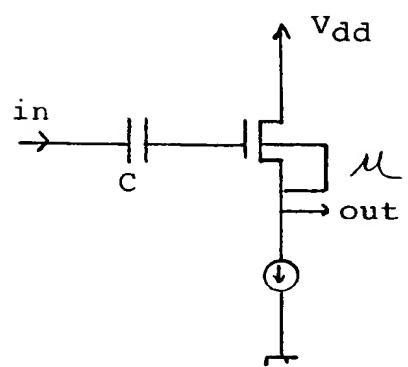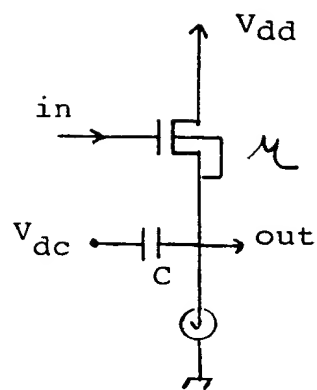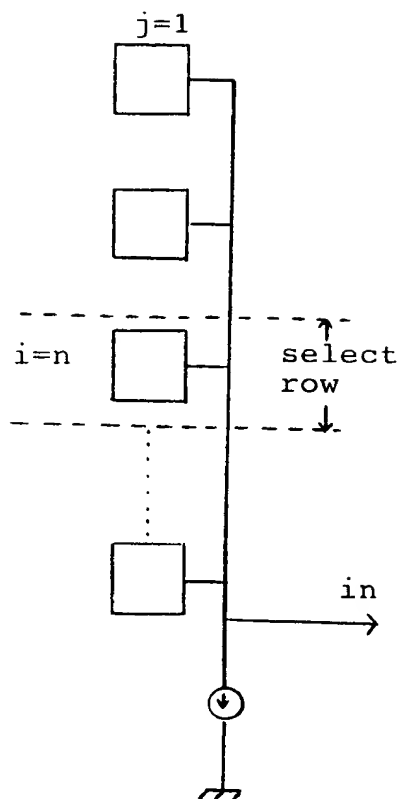
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FIG. 6
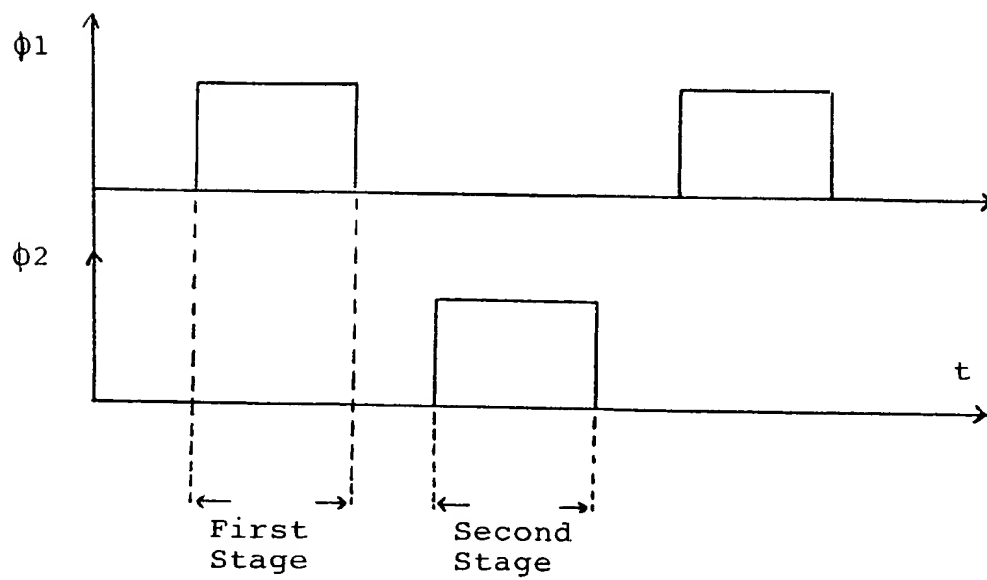
FIG. 7

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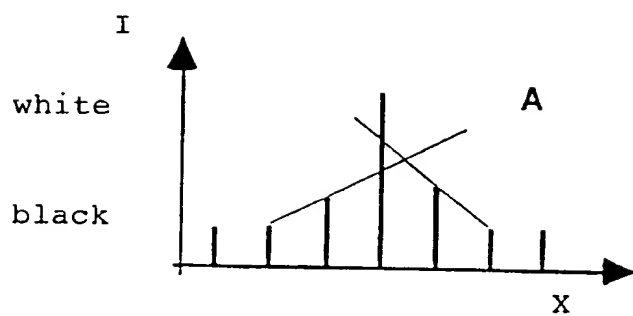
FIG. 8a

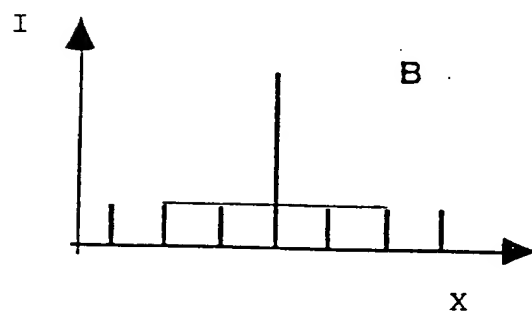FIG. 8b

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INTERNATIONAL SEARCH REPORT

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6   H04N3/15   H04N5/217

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 6   H04N

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and. where practical. search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	EP 0 773 669 A (IMEC INTER UNI MICRO ELECTR) 14 May 1997 see column 4, line 15 – line 39 see column 7, line 19 – line 30 ---	5,9
X	US 5 321 528 A (NAKAMURA KENICHI) 14 June 1994 see column 3, line 56 – column 4, line 53; claims 1-4 ---	5,9
X	MARTIN W J ET AL: "DYNAMIC OFFSET NULL" IBM TECHNICAL DISCLOSURE BULLETIN, vol. 23, no. 9, February 1981, page 4195/4196 XP002052268 see the whole document --- -/--	5,9

[X] Further documents are listed in the continuation of box C.   [X] Patent family members are listed in annex.

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
13 November 1998	18/12/1998

Name and mailing address of the ISA	Authorized officer
European Patent Office. P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Bequet, T

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INTERNATIONAL SEARCH REPORT

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document. with indication,where appropriate, of the relevant passages	Relevant to claim No.
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A	EP 0 481 373 A (SONY CORP) 22 April 1992 see column 4, line 31 - line 52; figure 1 -----	1,6

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